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I, KIM MARSHALL, MANAGER EXAMINATION SUPPORT AND SALES, hereby certify that the annexed is a true copy of the Provisional specification in connection with Application No. PP 2909 for a patent by GLENBORDEN PTY LTD. and SUNICOVE PTY LTD., filed on 9 April 1998.

PRIORITY DOCUMENT

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WITNESS my hand this Sixth
day of May 1999

KIM MARSHALL
MANAGER EXAMINATION SUPPORT AND SALES

AUSTRALIA

Patents Act 1990

ORIGINAL

PROVISIONAL SPECIFICATION

"FLUID REGULATOR FOR AN AEROSOL AND CONTAINER

The invention is described in the following statement:

FLUID REGULATOR FOR AN AEROSOL AND CONTAINER

FIELD

The present invention relates to a regulator, the regulation of pressure and/or fluid flow, and parts therefore. The present invention has particular but not exclusive application to aerosols, trigger pumps, their nozzles and other fluid delivery mechanisms and/or containers. In one form the present invention has specific application to actuators fitted to aerosols and may also be used in any application requiring fluid flow to be regulated to a near or substantially constant flow rate or pressure.

CROSS REFERENCE

Reference is made to co-pending applications entitled Fluid Regulator for a Trigger Pump, Diaphragm Regulator and 2 Part Regulator, filed on the same day by the present applicant, and hereinafter referred to respectively as Trigger Pump Application, Diaphragm Application and 2 Part Application. The disclosure of these applications is incorporated herein by reference.

BACKGROUND

A relatively large number of the worlds aerosols use hydrocarbon propellants. The hydrocarbon partially liquefies with the product and is able, in use, to maintain a relatively low internal pressure. As the product is dispersed from the aerosol, some of the remaining propellent transforms from a liquid to a gaseous state in order to maintain the internal pressure. However, the hydrocarbon propellents used are considered to effect the atmosphere by adding to so called 'green-house' gases, and are also flammable, making the aerosol potentially dangerous if exposed to heat.

Disposal of containers of aerosols having hydrocarbons as a propellant also poses a problem, in that although the propellant may be at or just above atmospheric pressure, the container has therein a flammable gas, discarded containers may pose an explosive danger, and recycling the container requires specialised equipment to ensure the containers are opened and crushed within chambers that capture the residual propellant.

From these, and other reasons, the aerosol industry would like to adopt an alternative technology, such as compressed rather than liquefied propellents.

Further problems exist with compressed propellents, in that, in order to ensure that there is enough propellent in the aerosol to disperse all the aerosols contents, the aerosol is initially filled to have a relatively high internal pressure. As the product in the aerosol is dispersed, the internal propellent pressure reduces dramatically. This change in propellent pressure does not enable the aerosol product to be delivered with relatively consistent discharge characteristics, such as flow rate and/ or droplet size.

To this end, various regulators have been proposed to be incorporated in the outlet nozzle associated with the aerosol, such as the regulator disclosed in UK patent application no. GB 2 216 634 A. This regulator, in use, however, is also considered to suffer a number of disadvantages, one of which is that the outlet flow is regulated somewhat by the inlet pressure of the gas. This can result in hunting of the valve and poor flow regulation when the inlet pressure fluctuates. The regulator disclosed in UK patent application No. 2 216 634 does not regulate pressure independent of inlet pressure is not likely to rapidly settle into regulation.

Further the regulator disclosed above includes six parts, and it is desirable to reduce the number of parts to reduce the cost of the regulator.

A further problem exists with existing aerosol technology. This relates to the refilling of aerosol containers, once the product has been dispensed so that the container of the aerosol cannot be reused, which may be unlawful.

SUMMARY OF INVENTION

It is an object of the present invention to alleviate at least one disadvantage associated with the prior art.

To this end, the present invention provides an aerosol including a compressed gaseous propellent, in which there is provided a fluid regulator to substantially regulate product dispersal flow.

The present invention is based on the realisation that the use of a fluid regulator in association with an aerosol having a compressed rather than liquefied gas propellant provides relatively consistent dispersal of aerosol product.

The compressed gaseous propellant mentioned above may include any

gas and includes those gases that liquefy readily when compressed, such as chloro-fluorocarbons and hydrocarbons. However, it should be understood that the present invention is particularly useful for the use of gases such as air, nitrogen and carbon dioxide as a propellant.

It is to be understood that the words 'compressed rather than liquefied propellent' and 'compressed gaseous propellent' does not exclude the fact that the compressed propellent is capable of liquification. The propellant as herein referred to may also be a pressurised gas or fluid, not necessarily liquified or compressed.

In one form, a balanced regulator of the type disclosed in US 5035260 may be used, however the regulator of this invention can also be seen as a modification of the regulator disclosed in US 5035260, as the shut off valve disclosed as a part of the US 5035260 regulator is not required in this invention.

The regulator of the present invention may be of any type of fluid regulator, one form of such regulator is disclosed in co-pending 2 Part application. The present application is also directed towards a regulator in an aerosol as described in co-pending Diaphragm application.

In one way, the present invention serves to operate on regulating generated pressure, that is, pressure already resident in an aerosol.

The present invention also includes a second aspect, namely an aerosol which includes an internal valve, such as a regulator (of any type) inside the aerosol container.

The second aspect is predicated on the realisation that by providing a valve internal of the aerosol container, it will be difficult, if at all possible, to refill aerosols. The internal valve may of the type disclosed herein, or may be a one-way valve.

A third aspect is directed to the present invention having a reduced number of parts as compared to prior art arrangements. This aspect is based on a balanced regulator for an aerosol actuator comprising a pressure surface, such as a diaphragm, connected to a spindle, the diaphragm being constructed from a material having spring like and sealing qualities, wherein the diaphragm is securely and sealingly attached to the actuator thus allowing the diaphragm

and spindle alone to regulate the flow through the actuator. In one embodiment, the diaphragm and spindle are combined to form a single part. This enables the actuator to comprise two parts, being the diaphragm and spindle combination being slidably received into the housing for the Actuator. Alternatively, the actuator may comprise three parts, wherein the diaphragm and spindle are separate parts which fit interlockingly together, and are slidably received into the housing of the actuator. In another alternative, the diaphragm and spindle may be made as one integral part.

In another form, the present invention includes a fluid regulator comprising a housing having an inlet and an outlet, said housing providing a first chamber open to the inlet, the first chamber being provided with a pair of substantially opposed ports which open to a second chamber, the second chamber having a third port opening to the outlet, an axial support element movable through the pair of ports and received within the first and second chambers, the support element supporting a pair of valve members wherein a valve member is associated with each of the pair of ports, the support element being movable within the first and second chambers to vary the extent of engagement of the pair of valve members with the pair of ports, said support element further supporting a pressure surface at the other end which is in the second chamber, whereby the force exerted by fluid pressure in the second chamber on the support element counteracts the open or rest force applied thereto to move the support element from its rest position to a regulating position where the pair of valves are moved proximate their respective ports to vary the degree of opening of the ports in accordance with the fluid pressure applied at the inlet.

Preferably the support element and the pressure surface can be combined in one part.

Preferably, the support element is supported by fluted bearing guides which allow fluid to flow between the chambers.

Preferably, the chambers are connected by a passage allowing the communication of fluid.

Preferably, the regulator is provided in an actuator.

In one form the balanced regulator does not include a shut off valve.

In the present application, an actuator is defined as the apparatus which is used to enable or open the valve of the aerosol container. The actuator may also be the portion of the aerosol activated by an operator in order to enable dipersal of the aerosol's contents. The actuator is typically an attachment having a nozzle and a surface that may be depressed by the user. Further, an aerosol includes the container for the propellant and active constituent and other matter to be dispersed, including the actuator.

In the present application the term fluid regulator is defined to mean an apparatus for the regulation and/or control of fluid flow, flow rate and/or pressure of flow.

One or more preferred embodiments of the present invention will now be described with reference to the accompanying drawings, wherein:

FIG. 1 is a sectional elevation of an aerosol cap incorporating a fluid regulator according to the first embodiment;

FIG. 2 is an enlarged view of the support element in position within the housing of the fluid regulator as shown at FIG. 1; and

FIG. 3a is a sectional elevation of a second fluid regulator embodiment incorporated internally within an aerosol container.

FIG. 3b is a sectional elevation of the second fluid regulator embodiment incorporated internally within an aerosol container rotated 90°.

FIG. 4 is a schematic representation of the embodiment shown in figure 1.

FIG. 5 is a graph of the outlet pressure in relation to deflection of a diaphragm of the fluid regulator of the present invention

FIG. 6a-6g are views of several embodiments of the diaphragm of the fluid regulator of the present invention.

Fig. 7 is a graph of force in relation to deflection of a typical Bellville spring device for the present invention.

The fluid regulator 11 as shown in FIGS. 1, 2 and 4 is intended to be utilised to deliver fluid at a substantially constant pressure to a spray nozzle 10 from a high pressure fluid source that may vary in its feed pressure. This fluid source may be an aerosol container containing a propellant such as air.

The nozzle regulator 11 comprises a housing 12 having an inlet 13 which opens into a first chamber 14 accommodated within the housing 12. The opposed walls of the first chamber 14 include a first and second port 15 and 16 respectively. The first port 15 connects one side of the first chamber 14 to one side of chamber 18 and to an outlet 17 provided in the housing 12 while the second port 16 connects the other side of the first chamber 14 to the other side of chamber 18. Each side of second chamber 18 communicates through a fluid passageway 19 which provides a relatively unrestricted communication of fluid ensuring an insignificant pressure difference between each side of the second chamber 18 and the outlet 17.

A spindle like support element 20 is received within the housing 12 such that it is axially slidable through the ports 15 and 16. The support element 20 supports two valve members 21 and 22 which are associated with the first and second ports 15 and 16 respectively. The first and second valves 21 and 22 are dimensioned such that they are either slidably receivable through the respective first and second ports 15 and 16 with a very close tolerance therebetween or have a small interference that when pushed through can not return.

The support element 20 has flutes 31 slidably received within the ports 15 and 16. The flutes are relieved to minimise flow resistance and to guide the support element 20.

The end of the support element 20 adjacent to the port 16 extends into the second chamber 18 and is provided with a ball-like head which is connected to a pressure surface such as a resilient diaphragm 201, via a ball and socket joint 202 or similar means of engagement. In another embodiment (not shown) the support element and flexible diaphragm can be combined to be one part.

The resilient diaphragm 201 is retained by a press fit or other suitable means of retaining the diaphragm 201 in the housing 12 in a substantially sealing arrangement.

The diaphragm 201 has spring like properties, in that it deflects under pressure but returns to its original shape or position after the removal of the fluid pressure. In the embodiment shown in figure 1, the spring like qualities of the diaphragm come from the shape of the diaphragm. Other examples of

diaphragms are shown in figures 6a-6g.

When at an open or rest position the first valve member 21 is adjacent but clear of the outlet side of port 15 while the second valve member 22 is located within the first chamber 14 and is adjacent to but clear of the other port 16. This allows fluid to flow from the first chamber 14 to the outlet 17 and also to chamber 18.

When in a closed position the engagement of the valve members 21 and 22 with the respective ports 15 and 16 is not a sealing engagement, but providing a restriction to the flow of fluid. The flutes 31 guide the support element 20 in the ports 15 and 16 and the engagement of the flutes 31 in the ports 15 and 16 is also not a sealing engagement.

On the application of sufficient fluid pressure to the inlet 13 fluid pressure is admitted to the outlet 17 and secondary chamber 18 through the two ports 15 and 16 respectively. Passageway 19 connects outlet 17 to secondary chamber 18 allowing a flow of fluid which balances the pressure in the chambers.

The pressure on the flexible diaphragm 201 causes it to deflect laterally which also causes the support element 20 to move from the open or rest position, to a pressure regulating position, such that the valve members 21 and 22 are brought into engagement with ports 15 and 16 respectively to restrict the flow from the first chamber 14 to the outlet 17 and second chamber 18. The passageway 19 ensures that there is little pressure differential between each side of the second chamber 18. The pressure at the outlet side of the first and second ports 15 and 16 is throttled by the degree of engagement of the first and second valves 21 and 22 with the first and second ports 15 and 16. Should there be a rise in the outlet pressure due to excess fluid flow, the degree of engagement increases thereby increasing throttling. Thus outlet pressure is regulated to remain substantially constant irrespective of supply pressure, above a certain minimum pressure and below a certain maximum pressure. Below the said minimum pressure the diaphragm 201 will have a small deflection so that the valve members 21 and 22 are not closely engaged with the ports 15 and 16 and thus the pressure is not throttled to a great extent.

In any case, this will only occur when the aerosol container is almost

empty, as normally the pressure in the can is substantially higher than the minimum outlet pressure.

Above the said minimum pressure and once flow commences, the first and second valve members 21 and 22 are brought into engagement with the ports 15 and 16 respectively to reduce the degree of communication of the fluid pressure applied at the inlet 13 to the second chamber 18. On the application of maximum fluid pressure to the inlet 13 both the first and second valve members 21 and 22 move to become almost fully engaged with the respective ports 15 and 16 which results in almost no fluid flow. Prior to the fluid flow terminating, the pressure in chamber 18 via passageway 19 and outlet 17 is reduced, therefore causing the diaphragm 201 to reduce its deflection thus creating a condition of fluid flow within predetermined limits.

The valve of the first embodiment may be schematically represented as shown in FIG. 4.

For any value of inlet pressure P1 the forces F1 cancel and for any value of outlet pressure P2 the forces F4 cancel. There are essentially no losses between the chamber 18 and the outlet 17 and thus P3=P2. The flexible diaphragm 201 has the pressure P2 acting on it over area A2-A3 plus a force F3. It should be noted that in at least one embodiment spring 28 is represented by the elastic properties of the materials used to manufacture the diaphragm.

F3-A3 . P3

P3=P2

Therefore

F3=A3 . P2

Thus the resultant force biasing the support element 20 to a throttling position is pressure P2 acting over the entire area A2, plus P3 acting over the area A3. The flexible diaphragm 201 has a pressure versus deflection curve as shown in FIG. 5.

If the supporting element 20 is in its open or rest position, any inlet pressure P2 is ported through the open valve members 21 and 22 and the ports 15 and 16. The pressure then acts in the chamber 18 against the flexible diaphragm 201 causing it to deflect according to its pressure versus deflection

curve as shown in FIG. 5. The deflection of the flexible diaphragm 201 causes the supporting element 20 to move and reduce the gap between the valve members 21 and 22 and the respective ports 15 and 16. The reduced gap between the valve members 21 and 22 and the respective ports 15 and 16 causes a restriction to flow which creates a pressure drop through the ports 15 and 16 so that the pressure P2 in the chamber 18 is lower than the inlet pressure P1. The size of the ports 15 and 16 and the stiffness of the flexible diaphragm 201 (which gives the pressure versus deflection curve shown in FIG. 5) is arranged so that for any inlet pressure P1 greater than the minimum regulating pressure (point A on FIG. 5) the outlet pressure P2 is throttled so that it remains substantially constant (between points A and B on FIG. 5).

The balance position for the support element 20 is one at which the pressure in the second chamber 18 is held at a level which the force Fs applied by the spring is balanced . If the pressure P2 in the second chamber 18 continues to increase, the support element is moved to bring the first and second valve members 21 and 22 into closer engagement with the first and second ports 15 and 16 respectively, to further throttle the flow between the inlet chamber 14 and the second chamber 18 so as to reduce P2 with respect to P1.

In order for the diaphragm 201 to operate, it is desirable to have a large range of movement over a relatively small pressure range. In this way, the support member 20 attached to the diaphragm can move a sufficient distance to open and close the valves 15 and 16 over a relatively narrow range of pressures compared to the range of pressures in the first chamber 14. To achieve this, it has been found that a diaphragm having a falling spring rate is desirable, ie more force is required to deflect the diaphragm the first unit of distance than is required to deflect the diaphragm the second unit of distance, as shown in Figure 5. The desired diaphragm and spring properties can be combined in the correct proportion such that only a small increase in force is required to produce a relatively large change in movement of the diaphragm and accordingly the support member.

The balance between the deflection and the spring rate of the diaphragm is determined by the properties of the materials used and the size and shape of

the diaphragm.

If the inlet pressure P1 is low (i.e. nearly equal to P2) the extent of throttling by the first and second valve member 15 and 16 is low and resistance to flow is low. If the inlet pressure P1 is much greater than the pressure P2 in the second chamber 18 the throttling by the first and second valve members 15 and 16 is greater. The minimal extent of movement of the spindle required to vary the extent of throttling to control the pressure P2 in the second chamber results in only a slight difference on the force Fs applied by spring 28 or the diaphragm 201. This implies a higher regulation of pressure for instances of a high inlet pressure than for low inlet pressures however in practice the difference in the degree of regulation has been found to be negligible.

The embodiments shown in figures 3a and 3b relate to the use of a pressure regulating valve inside an aerosol container. The advantage of this approach is that the container cannot be refilled easily. Refilling of the container is dangerous for the purchaser, as the contents may not be those marked on the container, the container may be damaged, or the contents may be at a higher pressure than is safe. Also product contamination is of concern.

A regulator 110 used in these embodiments includes an on-off valve. In normal usage, the regulator 110 works in a similar way as the regulator of previous embodiments. The regulator 110 is incorporated into the container and is therefore resistant to tampering.

On refilling, the pressure in the regulator 110, specifically in a chamber 118, increases. This causes valves 121 and 122 to move towards ports 115 and 116 respectively thus stopping or severely restricting the flow of fluid into the container and therefore preventing the container from being refilled.

This is a surprising result as the properties of fluid flow back into the regulator 110 were not known, and it is not obvious to use the regulator in an inbuilt fashion for this purpose.

The diaphragm used in this embodiment incorporates a separate spring 128 and diaphragm 129. The spring 128 and diaphragm 129, when separate can be matched to exhibit the same properties as diaphragm 201 of the other embodiment. It should be recognised that the embodiments of the spring and

diaphragm or diaphragm alone achieve the same result and therefore can be readily swapped.

As shown in figures 6a-6g, there are several different embodiments of the diaphragm. Diaphragm 130 is in the shape of a flat disc, with cylindrical sides 140 to provide a means of aligning the diaphragm during assembly, and to provide a seal against fluid leaking past the sides 140. The support member 20 is shown integral with the diaphragm 130, as are the other embodiments shown in figures 6a-6g, however, the diaphragm and support member may be separate and any suitable attachment means may be employed.

Diaphragm 131 includes an outer annular portion 141 and an inner annular portion 141a which are thinner than the rest of the disc, thus reducing the stiffness of the diaphragm, according to the desired pressure and displacement relationship required. Many such annular portions can be included to achieve a sufficiency in stiffness, however, a particular advantage has been discovered using at least two annular portions in that the thinner areas act as hinges allowing the support member 20 to move laterally. The hinges coalesce the stress in the annular portions 141, 141a. The annular portion may be on either side of the disc.

Diaphragm 132 is shown with the disc portion 142 including corrugations to enhance the movement of the disc in response to changes in pressure. The corrugations allow the disc to extend and therefore, provide the support member 20 with more lateral movement, while not stressing the material of the disc sufficiently to cause permanent plastic deformation. Annular portions as shown in Figure 6b may be included with the corrugations, to further increase the range of movement of the support member 20.

Diaphragm 133 includes a number of radial depressions 143, which reduce the stiffness of the disc to a desired level.

A further alternative is that the diaphragm may employ bellville spring design principles as shown in figure 6e. In this embodiment, the diaphragm is biased towards a concave position, shown in figure 6e. The concavity of the diaphragm depends on the pressure on the diaphragm 134. When there is no net pressure from the fluid acting on the diaphragm, ie no fluid flow, then the

diaphragm 134 is more concave. When there is fluid pressure acting on the diaphragm 134, then the pressure causes the diaphragm to move axially and becomes less concave, wherein the spring rate is reduced as shown in figure 5. When the pressure is released, the diaphragm springs back to its original position shown in figure 6e.

In figure 6f, there is shown a diaphragm 135 which includes a number of circular corrugations 144 orientated axially to produce a bellows arrangement, which allows increased axial movement whilst maintaining a more constant spring rate. The spindle 20, diaphragm 135 and corrugations 144 may all be made from the same material, such as a plastics material.

In figure 6g, there is shown a diaphragm 136 which includes one or a number of concentric rings or tubes 137 with a flexible attachment 138 therebetween. The flexible attachments 138 act like hinges with low radial stiffness, low bending stiffness and high axial stiffness. The small volume of material in these regions is allowed to operate at high stress. In doing so, they attract only a small proportion of the total strain energy applied to the diaphragm. The much larger volume concentric rings operate at a lower stress to reduce the effects of creep because due to their relative bulk, they absorb the majority of the total strain energy.

In Figure 7 the relationship between the force on a Bellville spring versus the deflection is shown. It can be seen that the force required to deflect the spring rises until a critical maximum point is reached. Either side of this critical maximum force, the spring rate reduces which results in a large movement in the diaphragm for a relatively small pressure change. This reduction in spring rate is desirable in that it provides a narrow range of pressures in which the outlet pressure may be regulated.

Additionally, there may be a shut off valve upstream from the outlet nozzle, in order to reduce the drying of any product left in the chambers after the flow has ceased. Typically, when residues of fluids such as paint and hairspray remain inside spray nozzles, they can dry and clog the nozzle. The shut off valve can be incorporated into the regulator between the chambers and the outlet in order to stop any drying of product.

Further, a check valve may be situated upstream from the inlet so that if the regulator is inverted, the valve will block the flow of propellant through the regulator. This ensures that propsellant is not lost from the aerosol container by expelling propellant without expelling the product, which, typically being a liquid in the can, would not enter the dip tube while the container was inverted.

It should be appreciated that the scope of the invention(s) disclosed need not be limited to the particular scope of the embodiment described above.

From the above descriptions, the diaphragms are designed symmetrically so that the support member 20 moves linearly when the diaphragm deflects under fluid pressure. The various axially symmetrical weakened portions in the diaphragm are designed to offer structural support to the support member 20 but retain enough elasticity to deflect enough when subjected to the fluid pressure during operation of the regulator. The surprising aspect of the diaphragm arrangements disclosed herein is that a plastic can be used as a valve and retain its elasticity properties over the expected use cycle of the regulator. This is due to the use characteristics of a regulator with an aerosol container, i.e. infrequent short bursts that do not allow creep or permanent plastic deformation to become significant to the operation of the regulator. It has been found that using a plastic with a good memory of its original position, such as acetal, is sufficient.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A fluid regulator comprising a housing having an inlet and an outlet, said housing providing a first chamber open to the inlet, the first chamber being provided with a pair of substantially opposed ports which open to a second chamber, the second chamber having a third port opening to the outlet, an axial support element movable through the pair of ports and received within the first and second chambers, the support element supporting a pair of valve members wherein a valve member is associated with each of the pair of ports, the support element being movable within the first and second chambers to vary the extent of engagement of the pair of valve members with the pair of ports, said support element further supporting a pressure surface at the other end which is in the second chamber, whereby the force exerted by fluid pressure in the second chamber on the support element counteracts the open or rest force applied thereto to move the support element from its rest position to a regulating position where the pair of valves are moved proximate their respective ports to vary the degree of opening of the ports in accordance with the fluid pressure applied at the inlet.

2. A fluid regulator as claimed in claim 1 wherein the support element and pressure surface can be combined to be one part.

3. A fluid regulator as claimed in claim 1 or 2 wherein the support element is supported by fluted bearing guides which allow fluid flow between the chambers.

4. A fluid regulator as claimed in any of claims 1 to 3 wherein the chambers are connected by a passage allowing the communication of fluid.

5. An aerosol including a compressed gaseous propellent, in which there is provided a balanced regulator to substantially regulate product dispersal flow.

6. An aerosol including a compressed gaseous propellent, in which there is provided a regulator as disclosed in co-pending 2 Part and Diaphragm applications to substantially regulate product dispersal flow.

7. The aerosol of claim 5 or 6 wherein the regulator is provided in an actuator.

8. An aerosol as claimed in claim 7, wherein the balanced regulator does not include a shut off valve.

9. An aerosol which includes a regulator (of any type) inside the aerosol vessel.

10. An aerosol as claimed in claim 9, wherein the regulator is a one way valve.

11. A regulator as herein disclosed.

12. A regulator as claimed in claim 11, wherein one face of the regulator valve acts as a shut off valve.

13. A regulator as claimed in claim 12, wherein the face, in use when regulating, is spaced from the outlet such that there is substantially no throttling of fluid flow through the outlet.

14. An aerosol including a regulator as claimed in any one of claims 12 or 13.

15. An aerosol having a regulator to control the flow of contents from the aerosol, and in which the propellant is a compressed, liquified and/or pressurised fluid.

16. The aerosol of claim 15, wherein the propellant is air.

DATED this 9th day of April, 1998

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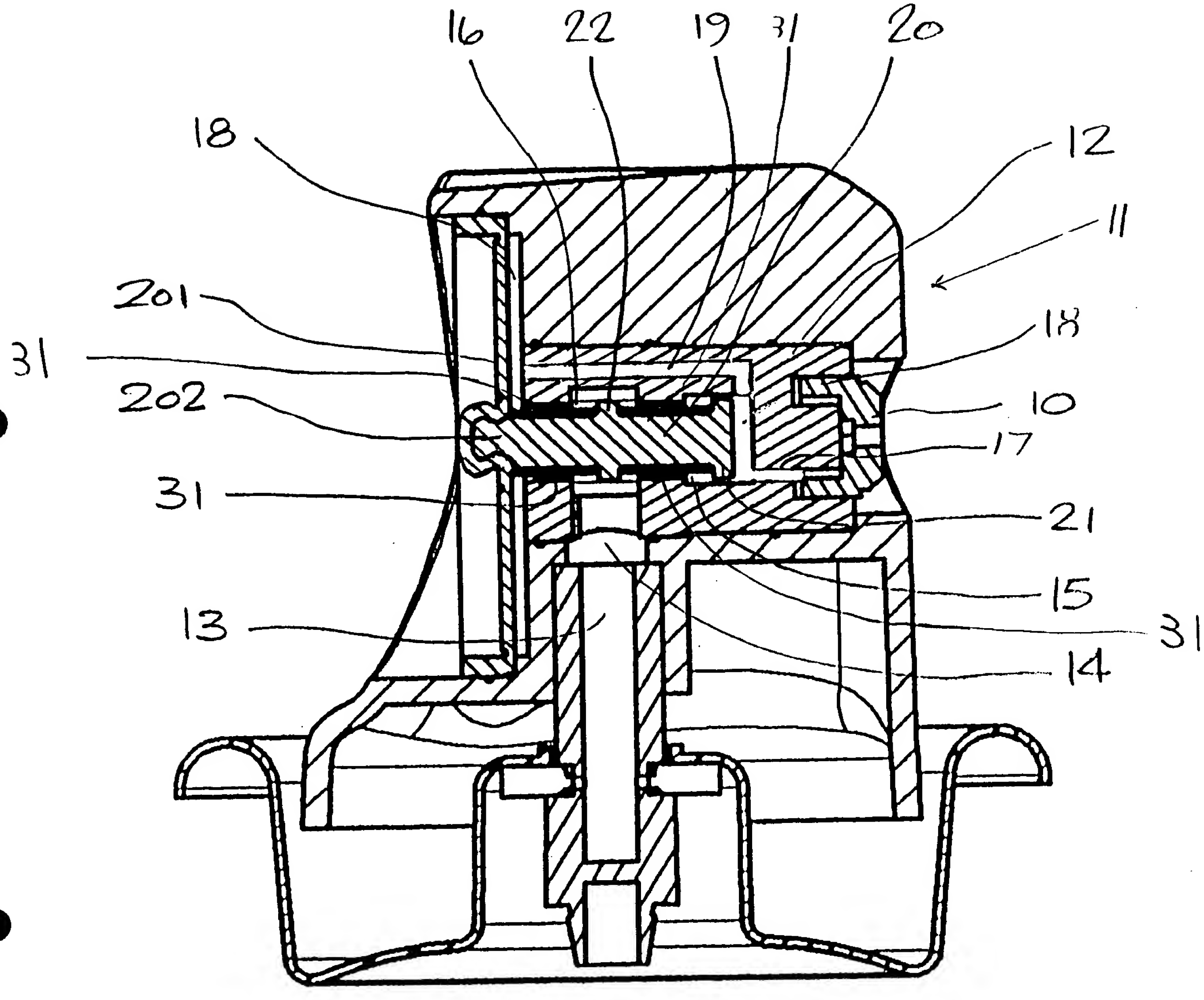


Fig 1

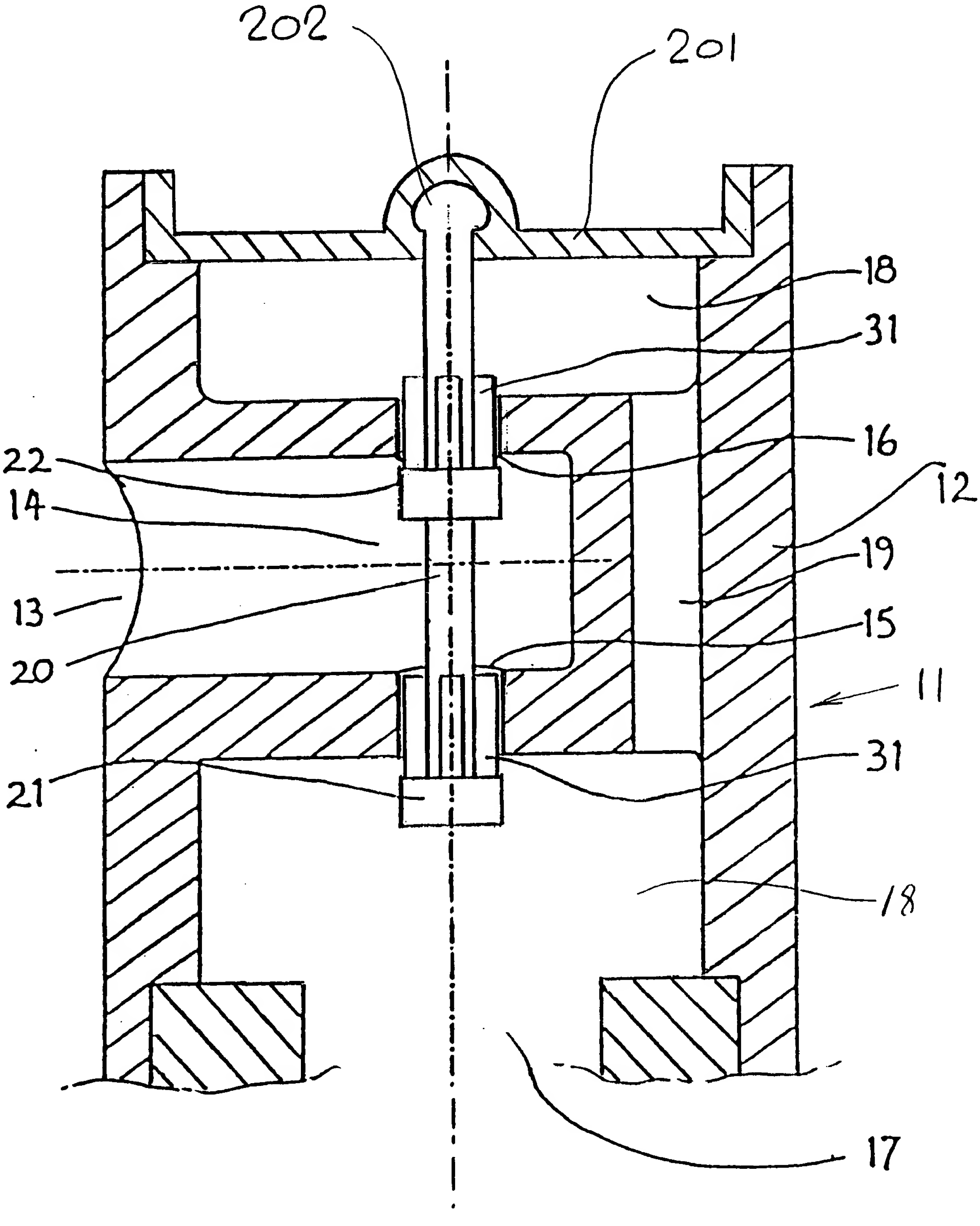


Fig. 2.

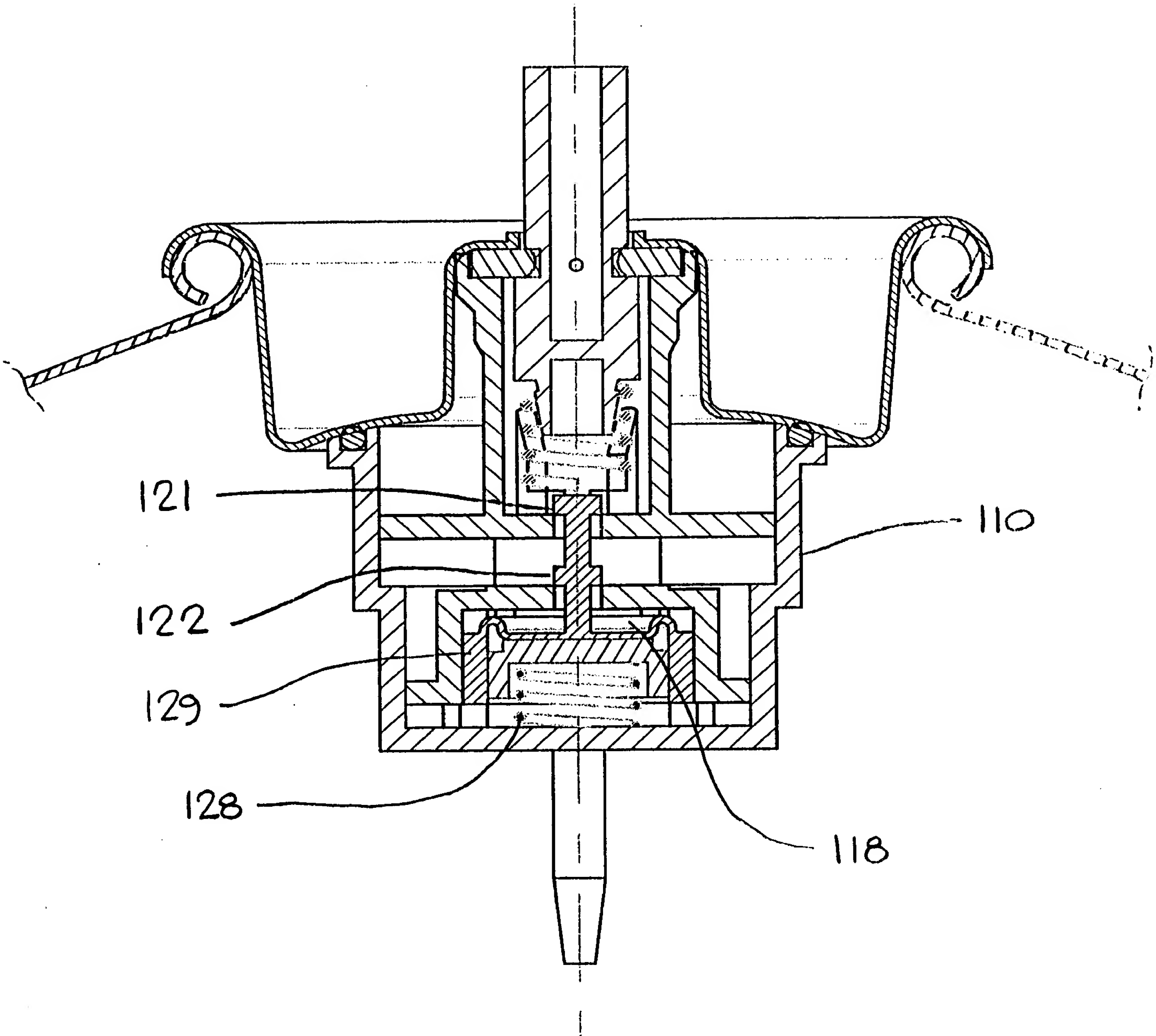


Fig 3a

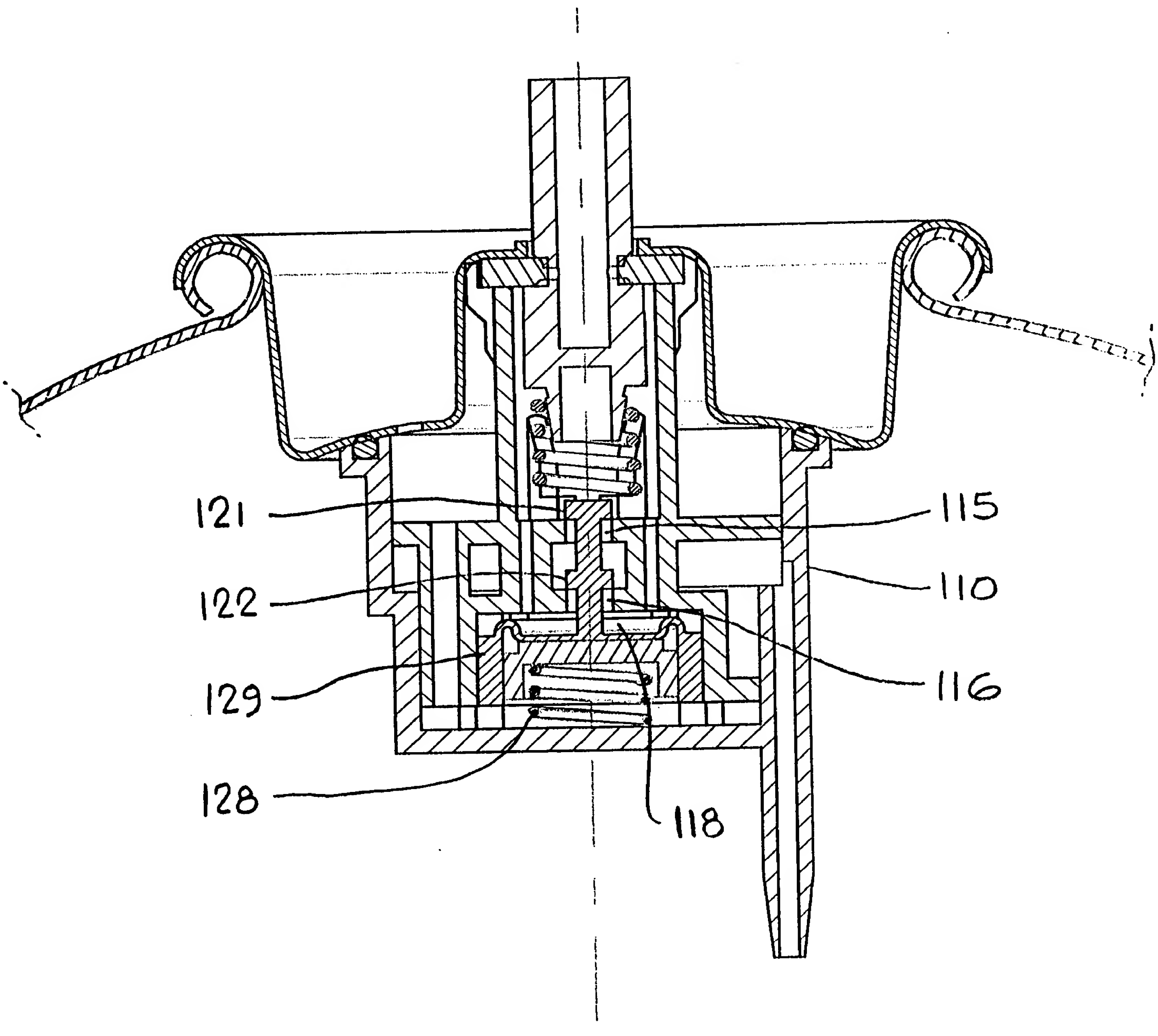
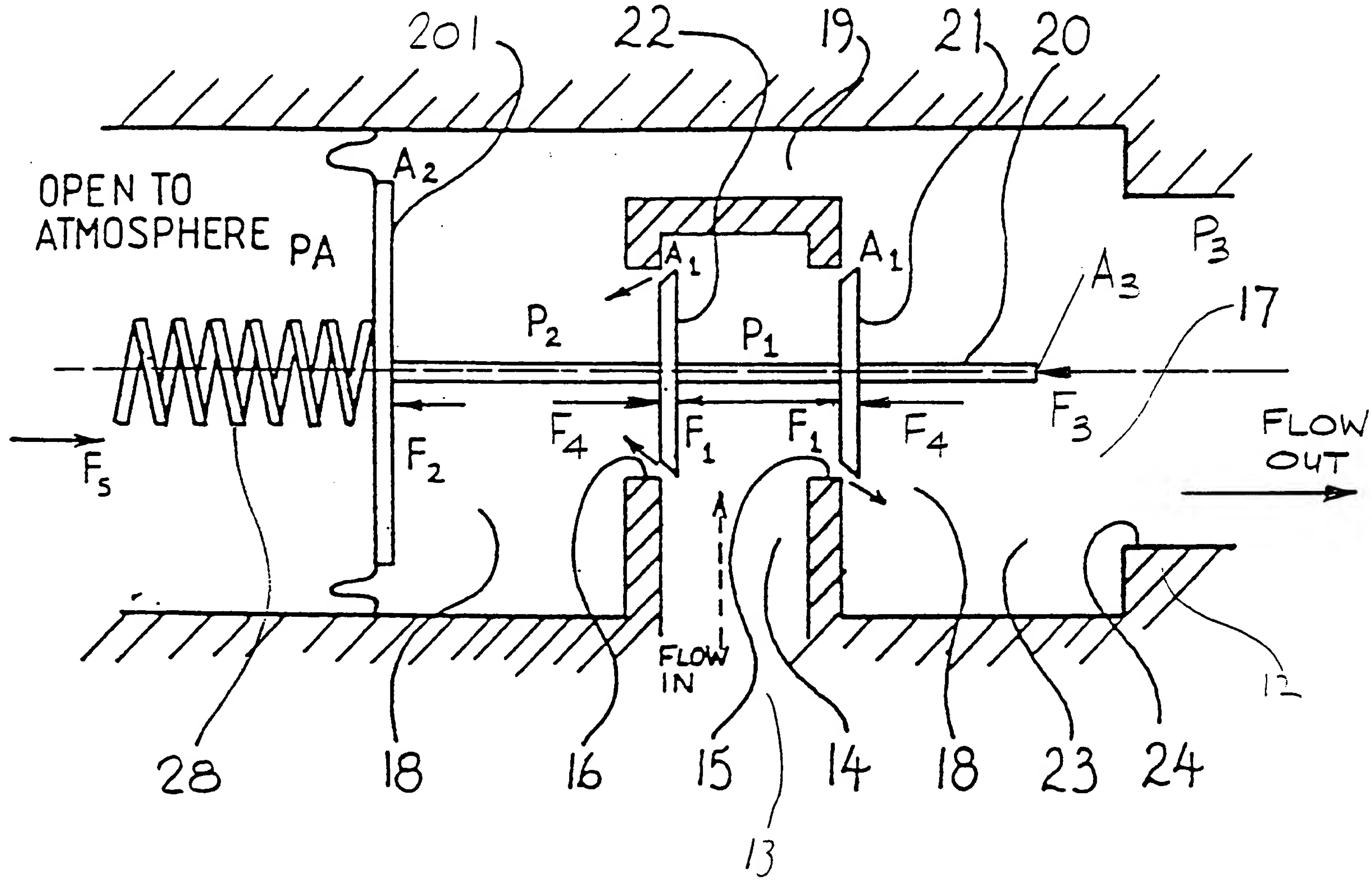


Fig 3b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A1
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F1
F4
F3
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23
24
13

Fig. 4.

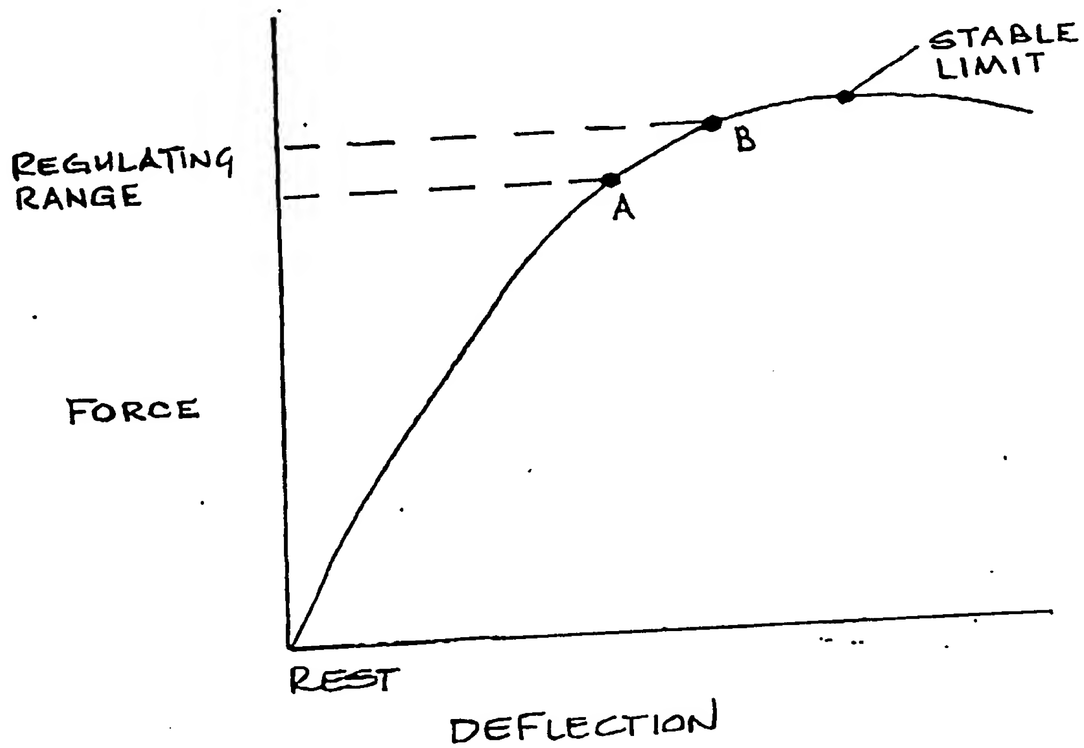


Fig 5

Fig 6a

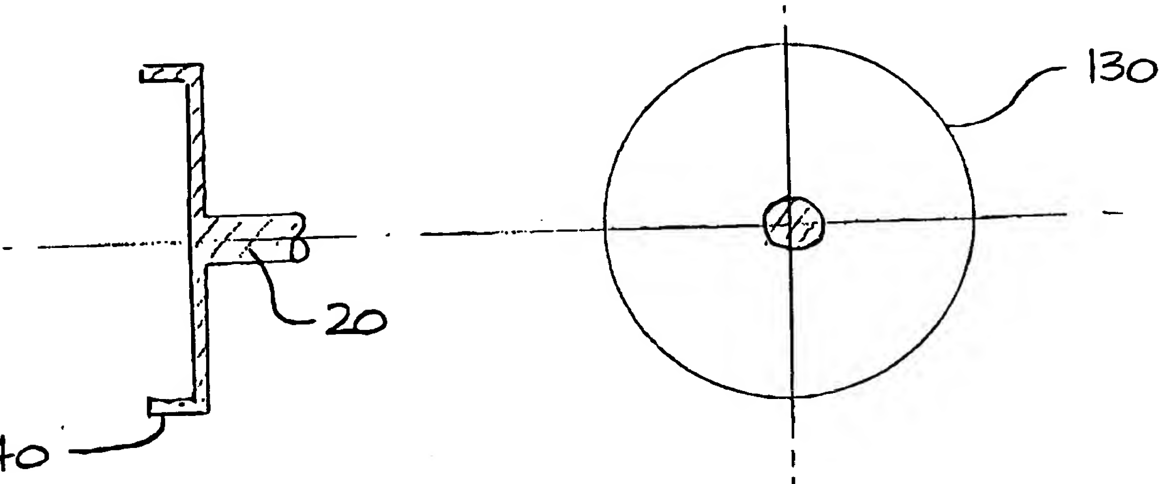


Fig 6b

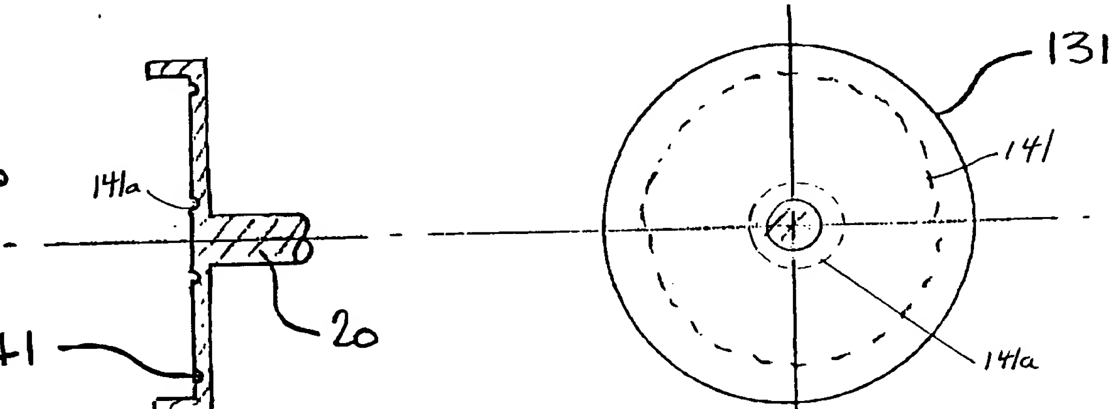


Fig 6c

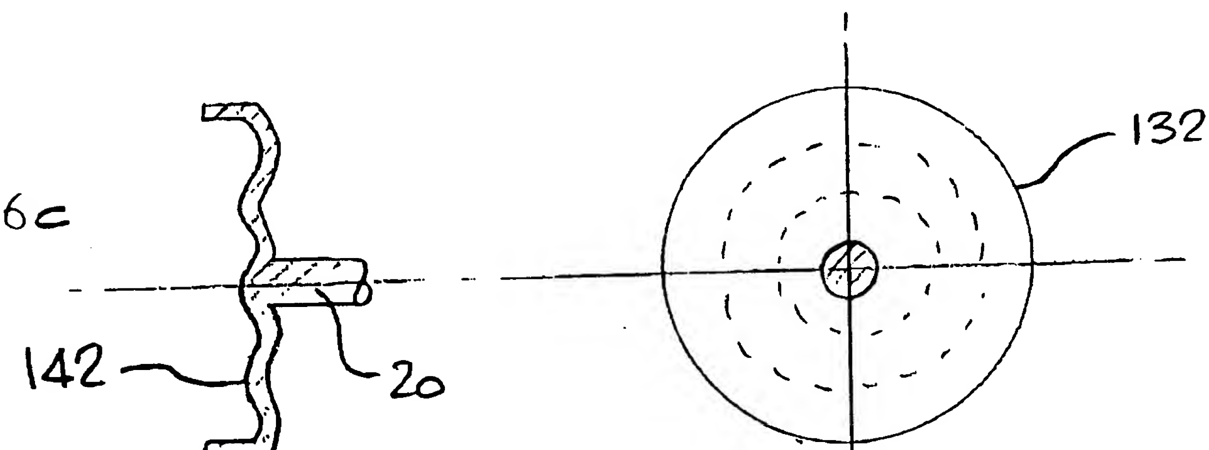


Fig 6d

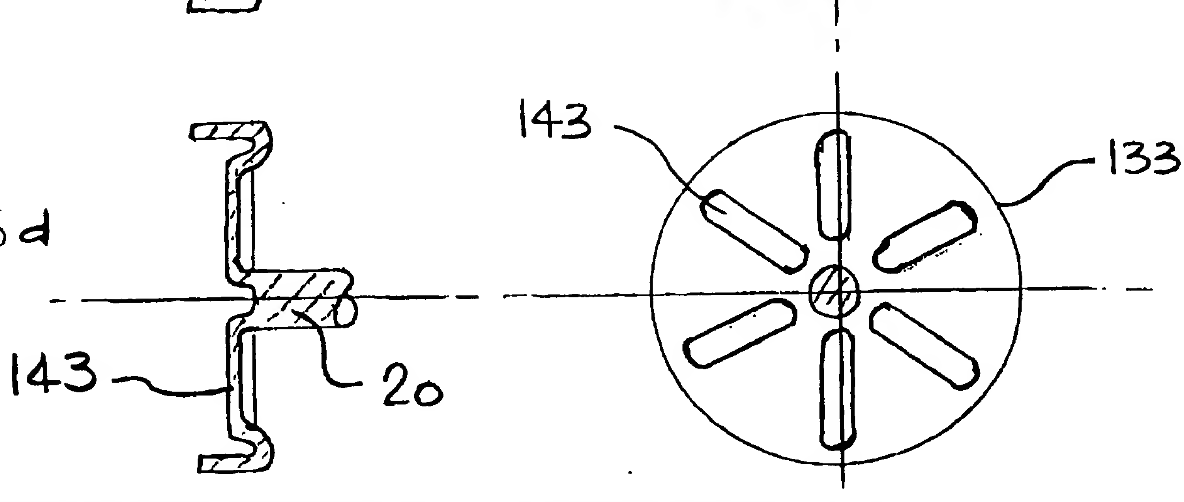
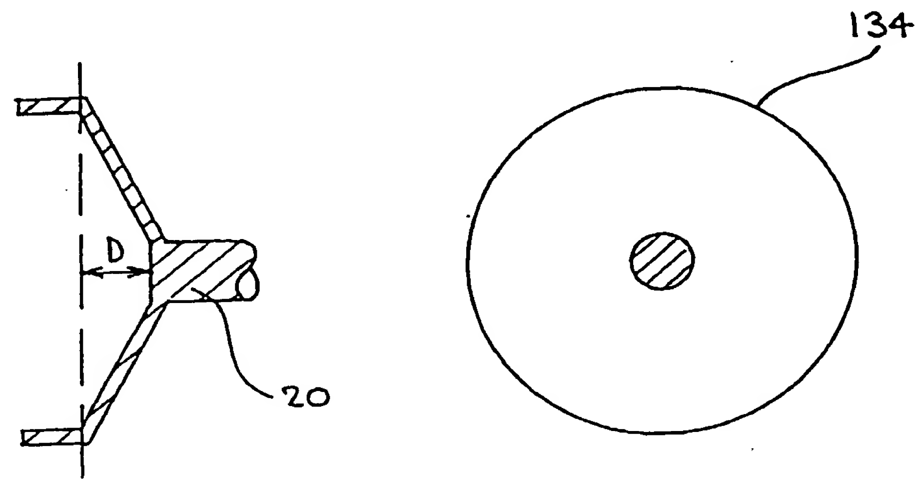


Fig 6e



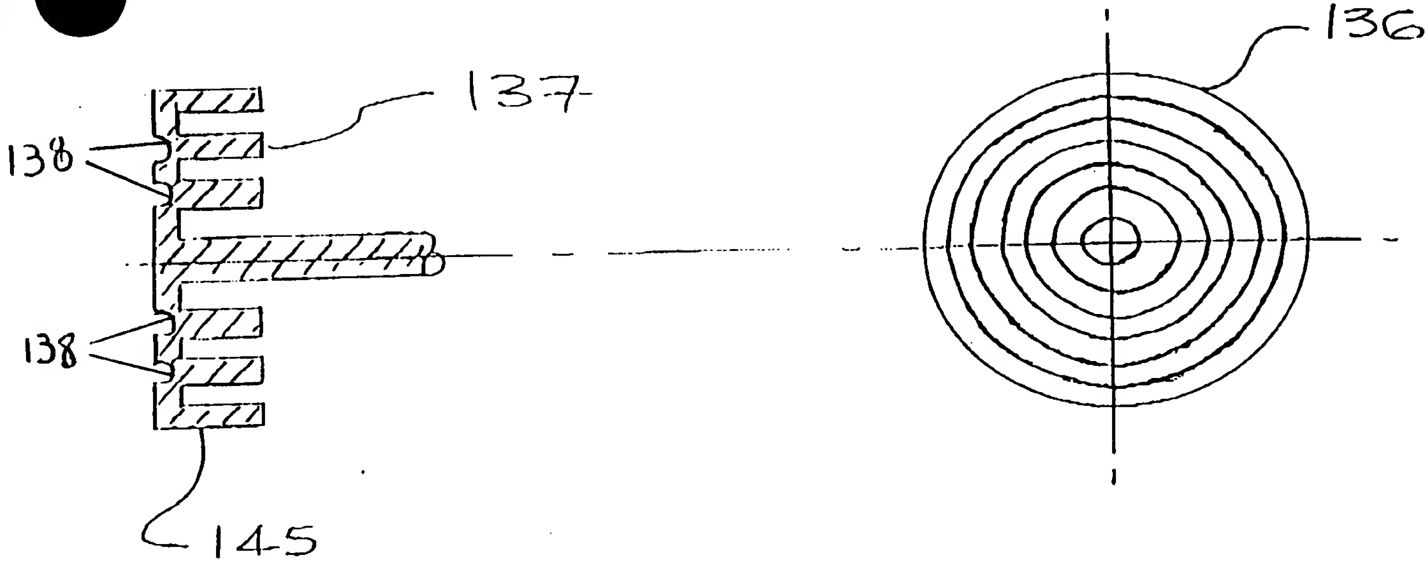


Fig 6g

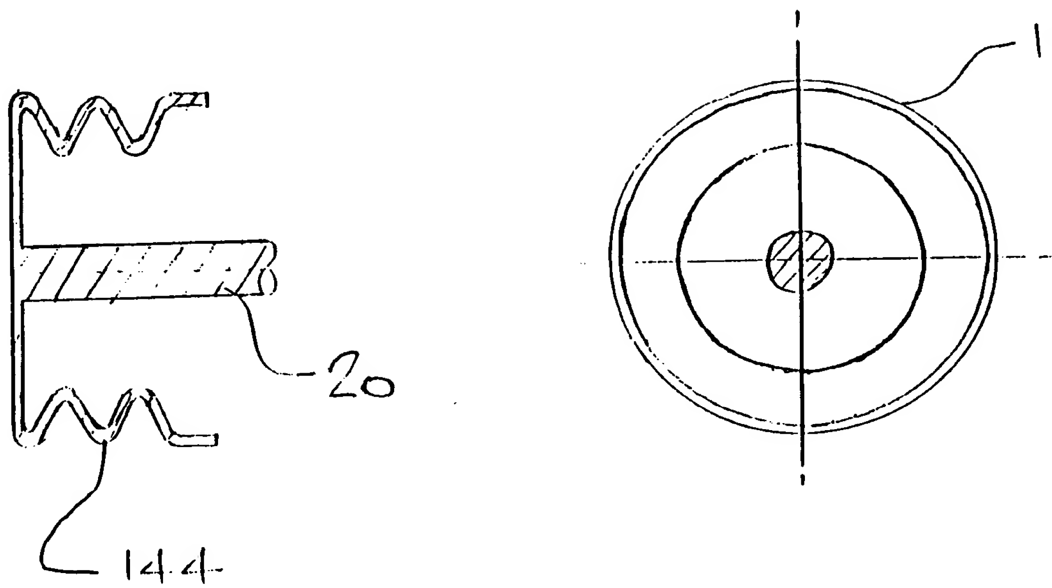


Fig 6f

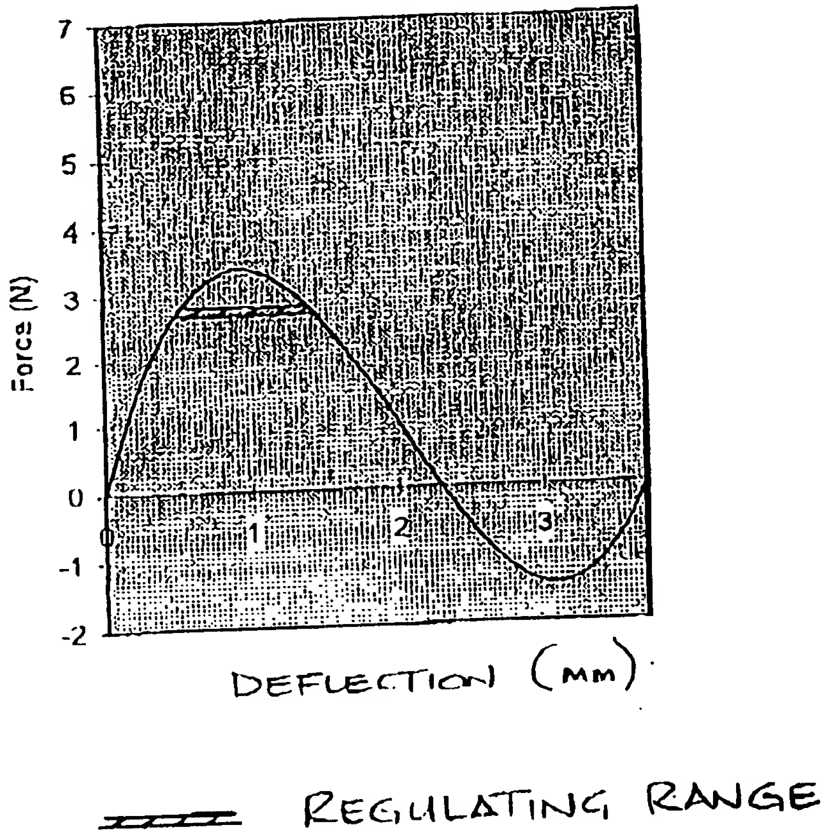


Fig 7